PATENT ABSTRACTS OF JAPAN

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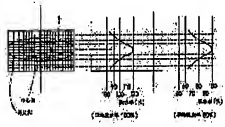
(71)Applicant : SHARP CORP
(72)Inventor : KOHAMA HARUYUKI

(54) METHOD FOR DRYING CERAMIC MOLDED ARTICLE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a method for drying a ceramic molded article by which a high quality ceramic molded article is obtd.
SOLUTION: When a ceramic molded article is dried by irradiation with microwaves, it is dried to 75-85% rate of dehydration with a microwave drier and is further dried to an oven-dry state with a hot air drier.



LEGAL STATUS

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CLAIMS

[Claim(s)]
[Claim 1] The desiccation approach of the ceramic mold goods characterized by consisting of the 1st desiccation process which it is [process] the desiccation approach of the ceramic mold goods which irradiate microwave and ceramic mold goods are made to dry, and dries ceramic mold goods to 75 - 85% of rate of dehydration with a microwave dryer, and the 2nd desiccation process which dries these ceramic mold goods to an absolute dry condition with hot air drying equipment.
[Claim 2] The desiccation approach of the ceramic mold goods which are the desiccation approaches of the ceramic mold goods which irradiate microwave and ceramic mold goods are made to dry, and are characterized by irradiating microwave in the condition of having floated ceramic mold goods from the base of the oven of a microwave drier.
[Claim 3] The desiccation approach of the ceramic mold goods which are the desiccation approaches of the ceramic mold goods which irradiate microwave and ceramic mold goods are made to dry, and are characterized by laying ceramic mold goods on a microwave absorption plate, and irradiating microwave.
[Claim 4] The press member for being the desiccation approach of the ceramic mold goods which irradiate microwave and ceramic mold goods are made to dry, and pressing the side face of ceramic mold goods, The fixture for contraction amendment equipped with the member from a cartridge which follows and maintains the condition that said press member pressed the side face of said ceramic mold goods while carrying out elastic energization of this press member in the press direction, to the contraction at the time of desiccation of said ceramic mold goods is prepared. The desiccation approach of the ceramic mold goods characterized by irradiating microwave where said ceramic mold goods are pushed against a fixed side with this fixture for contraction amendment.
[Claim 5] The desiccation approach of the ceramic mold goods which are the desiccation approaches of the ceramic mold goods which irradiate microwave and ceramic mold goods are made to dry, and are characterized by irradiating microwave where 45 degrees of ceramic mold goods are leaned to the level surface.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the desiccation approach of the ceramic mold goods of the shape of a honeycomb especially used for electric appliances, the flue gas treatment of an automobile, etc. about the desiccation approach of ceramic mold goods.
[0002]
[Description of the Prior Art] As everyone knows, ceramic honeycomb-like mold goods (henceforth ceramic mold goods) are widely used for electric appliances, the flue gas treatment of an automobile, etc. These ceramic mold goods are usually manufactured according to the following processes. That is, after carrying out extrusion molding of the plastic matter which added and kneaded a binder and water in the ceramic raw material to the shape of a honeycomb with an extruding press machine and cutting the ceramic mold goods of the obtained high water content in a predetermined dimension, even an absolute dry condition is mostly dried at a desiccation process, and it heat-treats at a baking process further.
[0003] ** dimensional accuracy is [that it has uniform ** contraction that it is important in the ceramic mold goods dried before the baking process, that there is no difference of dry density in the interior of ** mold goods, that there is no crack in the front face and the interior of ** mold goods and] uniform -- it comes out, it is, and unless it clears these conditions, the ceramic mold goods of high quality are not obtained.
[0004] Generally as the desiccation approach of ceramic mold goods, there are a heat desiccation method and an inner heat desiccation method using the energy of microwave outside [so-called] air drying, a forced drying, far infrared radiation desiccation, etc. Although the former is a method which transmits the heat energy of hot blast or a heater from the exterior of ceramic mold goods, since the exterior of ceramic mold goods contracts while desiccation inside ceramic mold goods is inadequate, the difference of internal and external drying shrinkage is large, and desiccation tends to become an ununiformity.
[0005] For this reason, conventionally, when drying ceramic mold goods, the method using the latter microwave energy is adopted. Although this method irradiates microwave within oven at ceramic mold goods, since the energy of microwave is absorbed from the interior by the moisture contained in the ceramic mold goods immediately after shaping, it is effective.
[0006] So that uniform desiccation can be performed with a microwave dryer in addition, in facility ** In order to ease the strength of microwave and the difference (electric-wave nonuniformity) of roughness and fineness by the location within oven, prepare the wing for churning. ** Lessen effect of electric-wave nonuniformity by moving ceramic mold goods within oven (revolution). ** Prevent electric-wave nonuniformity by driving the dispatch device of microwave mechanically and changing the dispatch direction of microwave. ** clearance of the steam discharged from desiccation at low temperature or ceramic mold goods is promoted by irradiating microwave, decompressing the inside of oven -- the means of ** is taken and the means of the above-mentioned ** - ** is together put suitably according to the appearance and construction material of ceramic mold goods. Moreover, in case ceramic rectangular parallelepiped-like mold goods are dried, in order to ease concentration of the microwave to the corner and edge of ceramic mold goods, the device of a wrap is made with metal covering in ceramic mold goods.
[0007]
[Problem(s) to be Solved by the Invention] However, in the Prior art mentioned above, the following problems have arisen depending on the number of the dimension of the binder to be used and ceramic mold goods, and the cels of a honeycomb, and an improvement is desired for quality and the improvement in the yield.
[0008] (Problem about the ununiformity of desiccation) When irradiating microwave within oven at ceramic mold goods and drying ceramic mold goods, in order to check whenever [progress / of the dryness], it has judged by measuring the weight change before and behind the microwave exposure of ceramic mold goods. That is, if the weight of mold goods decreases by the weight of the water to which it added water, it will be judged that it is an absolute dry condition. However,

the rate of dehydration is low as the interior of ceramic mold goods whose rate of average dehydration is 100% is shown in drawing 3 , and the core is the fault dryness of 100% or more of rates of dehydration and it goes to the periphery section from a core actually. If the part of fault desiccation is especially formed in the interior of ceramic mold goods, since the effectiveness of a binder or a shape retaining agent will deteriorate remarkably, this must be avoided.
[0009] Moreover, it becomes in inefficient, while the part (part of an ellipse form) which the energy of microwave concentrates may shift from the core of the ceramic mold goods 1 and desiccation becomes an ununiformity in this case, as microwave is shown in drawing 5 , when irradiating ceramic mold goods.
[0010] (Problem about dimensional accuracy) As mentioned above, ceramic mold goods are manufactured by extrusion molding, and are usually fabricated by extruding a plastic matter through metal mold with the revolution extrusion pressure of the screw of a making machine, but in order to ease torsion of a plastic matter, the pressure equalizer and the straightening vane are formed in the making machine. However, ceramic mold goods have the directivity of a plastic matter potentially, and the directivity may have big curvature rather than is necessarily linear. Therefore, even if it can perform to some extent uniform desiccation, distortion of the appearance accompanying the contraction at the time of desiccation occurs.
[0011] In addition, as an approach for making homogeneity dry ceramic mold goods, although the thing of JP,5-24876,B is well-known, if the invention in this application applies to the ceramic mold goods of the target ** so that a honeycomb in order to perform microwave desiccation, after performing hot air drying, by this approach, a crack will arise on a front face by the difference in contraction of the interior and the exterior.
[0012] This invention solves the trouble mentioned above and is to offer the desiccation approach of ceramic mold goods that the ceramic mold goods of high quality were obtained.
[0013]
[Means for Solving the Problem] In order to attain the above-mentioned object, the desiccation approach of the ceramic mold goods of claim 1 is the desiccation approach of the ceramic mold goods which irradiate microwave and ceramic mold goods are made to dry, and is characterized by to consist of the 1st desiccation process which dries ceramic mold goods to 75 - 85% of rate of dehydration with a microwave dryer, and the 2nd desiccation process which dries these ceramic mold goods to an absolute dry condition with hot air drying equipment.
[0014] In addition, 80 - 85% of the rate of dehydration of the ceramic mold goods in the 1st desiccation process is desirable when the magnitude of the cel of a honeycomb is 300-400 (a mesh / 1 square inch), and when the magnitude of the cel of a honeycomb is 100-200 (a mesh / 1 square inch), it is desirable. [75 - 80% of] Moreover, as for the temperature of the hot blast of hot air drying equipment, it is desirable that it is 100 degrees C or less.
[0015] Since according to this desiccation approach ceramic mold goods are dried to 75 - 85% of rate of dehydration at the 1st desiccation process and it is subsequently made to dry to an absolute dry condition at the 2nd desiccation process, while ceramic mold goods can dry from the interior and the outside and being able to make homogeneity dry the whole ceramic mold goods, it can prevent that the core of ceramic mold goods becomes fault desiccation.
[0016] The desiccation approach of claim 2 is the desiccation approach of the ceramic mold goods which irradiate microwave and ceramic mold goods are made to dry, and is characterized by irradiating microwave in the condition of having floated ceramic mold goods from the base of the oven of a microwave drier.
[0017] According to this desiccation approach, the energy of microwave is absorbed also from the pars basilaris ossis occipitalis of ceramic mold goods. Moreover, the location which the energy of microwave concentrates, and the core of ceramic mold goods can be doubled. Therefore, uniform desiccation is attained while drying efficiency improves.
[0018] The desiccation approach of claim 3 is the desiccation approach of the ceramic mold goods which irradiate microwave and ceramic mold goods are made to dry, and is characterized by laying ceramic mold goods on a microwave absorption plate, and irradiating microwave.
[0019] Uniform desiccation is attained while drying efficiency improves, since the energy of microwave is absorbed also from the pars basilaris ossis occipitalis of ceramic mold goods

according to this desiccation approach.
[0020] The press member for the desiccation approach of claim 4 being the desiccation approach of the ceramic mold goods which irradiate microwave and ceramic mold goods are made to dry, and pressing the side face of ceramic mold goods, The fixture for contraction amendment equipped with the member from a cartridge which follows and maintains the condition that said press member pressed the side face of said ceramic mold goods while carrying out elastic energization of this press member in the press direction, to the contraction at the time of desiccation of said ceramic mold goods is prepared. It is characterized by irradiating microwave, where said ceramic mold goods are pushed against a fixed side with this fixture for contraction amendment.
[0021] Although the class of member from a cartridge and especially construction material are not limited, a metal flat spring and a metal coil spring can be used, for example.
[0022] In order that according to this desiccation approach the contraction at the time of desiccation of ceramic mold goods may be followed and a press member may continue pressing the side face of ceramic mold goods, the curvature accompanying the contraction at the time of desiccation of ceramic mold goods is controlled.
[0023] The desiccation approach of claim 5 is the desiccation approach of the ceramic mold goods which irradiate microwave and ceramic mold goods are made to dry, and is characterized by irradiating microwave, where 45 degrees of ceramic mold goods are leaned to the level surface.
[0024] According to this desiccation approach, the curvature accompanying the contraction at the time of the desiccation at the time of desiccation of ceramic mold goods is controlled by the self-weight of ceramic mold goods.
[0025]
[Embodiment of the Invention] Hereafter, the gestalt of concrete operation of this invention is explained, referring to a drawing. The ceramic mold goods before the desiccation used with this operation gestalt It is what was cut, after ****(ing) the plastic matter which kneaded the mixture of combination of the table 1 of the following page with the kneading machine, and was obtained with 3 rolls and carrying out extrusion molding to the shape of a honeycomb with an extruding press machine. It has a rectangular parallelepiped-like configuration, a dimension is 200mm in the side of 90mm, height of 40mm, and die length, and weight is [200 and the moisture content of 700g and the number of cels of a honeycomb] 100 cc. In addition, in the rate of a compounding ratio of a table 1, when 7 weight sections and paper pulp are made into 2 weight sections and water is made into 25 weight sections, it has become clear methyl cellulose that a desirable result is obtained especially.
[0026]
[A table 1]

		重量部
セラミック原料	炭化珪素（ＳｉＣ）	７０
	金属シリコン（Ｍｅ－Ｓｉ）	３０
バインダー	メチルセルロース（ＭＣ）	５～１０
	保形剤（紙パルプ）	１～３
水		２０～３０

[0027] The fixture 2 for desiccation used for drawing 1 at the time of desiccation of these

ceramic mold goods is shown. This fixture 2 for desiccation is equipped with the metal coverings 4 and 4 of the vertical couple for preventing concentration of the water retention covering 3 for preventing desiccation of the front face of the ceramic mold goods 1, and the microwave to the corner and edge of the ceramic mold goods 1. The ceramic mold goods 1 are set to this fixture 2 for desiccation in the center section in the oven of fitting and a microwave drier, microwave is irradiated, and the ceramic mold goods 1 are dried.

[0028] First, the 1st operation gestalt of this invention is explained. The desiccation approach of this operation gestalt consists of the 1st desiccation process which dries the ceramic mold goods 1 to 75 – 85% of rate of dehydration with a microwave dryer, and the 2nd desiccation process which dries these ceramic mold goods 1 to an absolute dry condition with hot air drying equipment.

[0029]

[Example] The ceramic mold goods 1 were inserted in the fixture 2 for desiccation, it set in the oven of a microwave drier, and 1.1kW microwave was irradiated for 4 minutes. Drawing 2 is Graf who shows the heating time by microwave, and the correlation of the rate of average dehydration of the ceramic mold-goods 1 whole. As shown to this Graf, the rate of average dehydration of the ceramic mold-goods 1 whole reaches to 100% in 5 minutes, but at this time, the rate of dehydration is falling as the condition of the ceramic mold-goods 1 interior is shown in drawing 3 , and the core is in the condition of fault desiccation of 100% or more of rates of dehydration and it dies in the periphery section. If it calcinates in this condition, it will lead to deterioration of reinforcement or quality. So, irradiation time of microwave is made into 4 minutes when the rate of dehydration of the ceramic mold-goods 1 whole becomes 80% at this 1st desiccation process. In this case, as shown in drawing 3 , the rate of dehydration is low, so that the rate of dehydration of the core of the ceramic mold goods 1 dies in the periphery section at about 100%.

[0030] The ceramic mold goods 1 dried to the above-mentioned condition at the 1st desiccation process are dried to an absolute dry condition with hot air drying equipment at the 2nd desiccation process. The desiccation conditions at this time make temperature of hot blast 100 degrees C or less, the ceramic mold goods 1 are set in hot air drying equipment 5 so that hot blast may be equivalent to the end face (opening section) of a honeycomb, as shown in drawing 4 , and the drying time is 60 minutes. The ceramic mold goods obtained by this were the things of high quality without a crack by which the whole contraction was stabilized.

[0031] Next, the 2nd operation gestalt of this invention is explained. If the exposure condition of the microwave within oven 6 is checked when drying ceramic mold goods with a microwave drier, as shown in drawing 5 , it will irradiate from the upper part of the ceramic mold goods 1, it will reflect with the wall and the fixture 2 for desiccation of oven 6, and microwave will be absorbed by the ceramic mold goods 1. If the location (part of an ellipse form) which the energy of microwave concentrates, and the core of ceramic mold goods have shifted as shown in drawing 5 , while desiccation will become an ununiformity, drying efficiency worsens. So, in this operation gestalt, as shown in drawing 6 , the ceramic mold goods 1 are floated from base 6a of oven 6, and microwave is irradiated in this condition at the ceramic mold goods 1.

[0032] According to this desiccation approach, the location which the energy of microwave concentrates, and the core of ceramic mold goods can be made in agreement. Moreover, the energy of microwave is absorbed also from the pars basilaris ossis occipitalis of ceramic mold goods. Therefore, uniform desiccation is attained while drying efficiency improves.

[0033] Next, the 3rd operation gestalt of this invention is explained. With this operation gestalt, as shown in drawing 7 , the ceramic mold goods 1 are laid on the microwave absorption plate 7, and microwave is irradiated.

[0034] Uniform desiccation is attained while drying efficiency improves, since the energy of microwave is absorbed also from the pars basilaris ossis occipitalis of the ceramic mold goods 1 according to this desiccation approach.

[0035] Next, the 4th operation gestalt of this invention is explained. With the above-mentioned operation gestalt, when the ceramic mold goods 1 are dried, the breadth contracts from 90mm to 85mm. And since the peculiarity of the plastic matter at the time of shaping serves as curvature

and it appears in case it contracts, the amendment is required. Then, the press member 9 for pressing the side face of the ceramic mold goods 1 with this operation gestalt, as shown in drawing 8 and 9, The fixture 8 for contraction amendment equipped with the member 10 from a cartridge which maintains the condition that followed the contraction at the time of desiccation of the ceramic mold goods 1, and the press member 9 pressed the side face of the ceramic mold goods 1 while carrying out elastic energization of this press member 9 in the press direction is prepared. Microwave is irradiated where the ceramic mold goods 1 are pushed against the fixed side 11 with this fixture 8.

[0036] In the thing of drawing 8 , the member 10 from a cartridge is the flat spring which turned up one edge of a band-like metal plate in the shape of an R, and this member 10 from a cartridge is attached in the inner surface of the side attachment wall of the fixture 2 for desiccation by spot welding. With the fixture 8, one side face of the ceramic mold goods 1 is pressed, and the side face of another side is forced on the fixed side 11. Since the press member 9 will move in the direction of an arrow head by the member 10 from a cartridge, contraction of the ceramic mold goods 1 will be followed and the press member 9 will continue pressing the side face of the ceramic mold goods 1 as shown in drawing 8 (b) if the ceramic mold goods 1 contract from the condition before the desiccation shown in drawing 8 (a), the curvature of the ceramic mold goods 1 is controlled.

[0037] In the thing of drawing 9 , the member 10 from a cartridge is a coil spring, and the end is being fixed to the inner surface of the side attachment wall of the fixture 2 for desiccation. Other configurations are the same as that of the thing of drawing 8 . Since the press member 9 will move in the direction of an arrow head by the member 10 from a cartridge, contraction of the ceramic mold goods 1 will be followed and the press member 9 will continue pressing the side face of the ceramic mold goods 1 as shown in drawing 9 (b) if the ceramic mold goods 1 contract from the condition before the desiccation shown in drawing 9 (a), the curvature of the ceramic mold goods 1 is controlled.

[0038] Next, the 5th operation gestalt of this invention is explained. With this operation gestalt, as shown in drawing 10 , the ceramic mold goods 1 are carried on susceptor 12, and after the ceramic mold goods 1 have inclined to 45 degrees to the level surface, microwave is irradiated.

[0039] According to this desiccation approach, the curvature at the time of desiccation of the ceramic mold goods 1 is controlled by the self-weight of the ceramic mold goods 1.

[0040]

[Effect of the Invention] Since according to the desiccation approach of the ceramic mold goods of claim 1 ceramic mold goods are dried to 75 – 85% of rate of dehydration at the 1st desiccation process and it is subsequently made to dry to an absolute dry condition at the 2nd desiccation process, while ceramic mold goods can dry from the interior and the outside and being able to make homogeneity dry the whole ceramic mold goods, it can prevent that the core of ceramic mold goods becomes fault desiccation. Therefore, the ceramic mold goods of high quality can be obtained.

[0041] Since microwave is irradiated in the condition of having floated ceramic mold goods from the base of the oven of a microwave drier according to the desiccation approach of the ceramic mold goods of claim 2, the energy of microwave is absorbed also from the pars basilaris ossis occipitalis of ceramic mold goods. Moreover, uniform desiccation is attained, while the location which the energy of microwave concentrates, and the core of ceramic mold goods can be doubled and drying efficiency improves. Therefore, the ceramic mold goods of high quality can be obtained.

[0042] Uniform desiccation is attained, while the energy of microwave is absorbed also from the pars basilaris ossis occipitalis of ceramic mold goods and drying efficiency improves, since according to the desiccation approach of the ceramic mold goods of claim 3 ceramic mold goods are laid on a microwave absorption plate and microwave is irradiated. Therefore, the ceramic mold goods of high quality can be obtained.

[0043] The press member for pressing the side face of ceramic mold goods according to the desiccation approach of the ceramic mold goods of claim 4, The fixture for contraction amendment equipped with the member from a cartridge which follows and maintains the

condition that said press member pressed the side face of said ceramic mold goods while carrying out elastic energization of this press member in the press direction, to the contraction at the time of desiccation of said ceramic mold goods is prepared. Since microwave is irradiated where ceramic mold goods are pushed against a fixed side with this fixture for contraction amendment, the contraction at the time of desiccation of ceramic mold goods is followed, a press member continues pressing the side face of ceramic mold goods, and the curvature accompanying the contraction at the time of desiccation of ceramic mold goods is controlled. Therefore, the ceramic mold goods of high quality can be obtained.

[0044] Since according to the desiccation approach of the ceramic mold goods of claim 5 microwave is irradiated where 45 degrees of ceramic mold goods are leaned to the level surface, the curvature accompanying the contraction at the time of desiccation of ceramic mold goods is controlled by the self-weight of ceramic mold goods. Therefore, the ceramic mold goods of high quality can be obtained.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The perspective view of the ceramic mold goods 1 and the fixture 2 for desiccation.
[Drawing 2] Graf who shows the heating time by microwave, and the correlation of the rate of average dehydration of the ceramic mold-goods 1 whole.
[Drawing 3] Drawing showing the dryness of the ceramic mold-goods 1 interior.
[Drawing 4] Drawing showing the condition of having set the ceramic mold goods 1 to the hot-air-drying-equipment 5 interior.
[Drawing 5] Drawing showing the condition inside [oven 6] a microwave drier.
[Drawing 6] Drawing in which showing the 2nd operation gestalt of this invention, and showing the condition inside [oven 6] a microwave drier.
[Drawing 7] Drawing in which showing the 3rd operation gestalt of this invention, and showing the condition inside [oven 6] a microwave drier.
[Drawing 8] Drawing in which showing the 4th operation gestalt of this invention, and showing the condition of drying the ceramic mold goods 1 using the fixture 8 for contraction amendment.
[Drawing 9] Drawing in which showing the 4th operation gestalt of this invention, and showing the condition of drying the ceramic mold goods 1 using the fixture 8 for contraction amendment.
[Drawing 10] Drawing in which showing the 5th operation gestalt of this invention, and showing the condition of leaning 45 degrees of ceramic mold goods 1, and drying them to the level surface.
[Description of Notations]
1 Ceramic Mold Goods
5 Hot Air Drying Equipment
6 Oven of Microwave Drier
7 Microwave Absorption Plate

8 Fixture for Contraction Amendment
9 Press Member
10 Member from Cartridge

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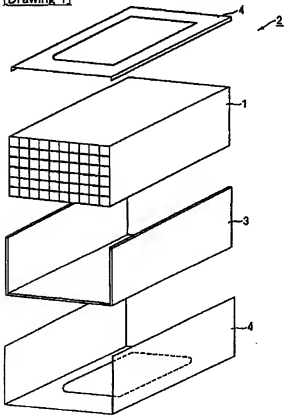
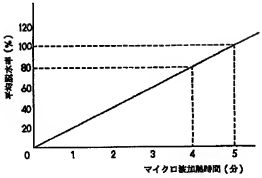
DRAWINGS

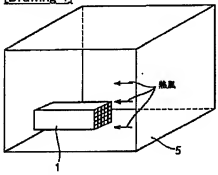
[Drawing 1]



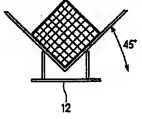
[Drawing 2]



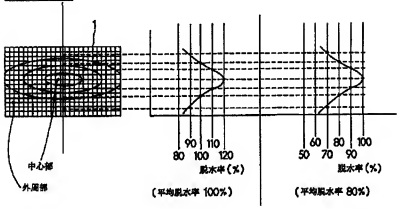
[Drawing 4]



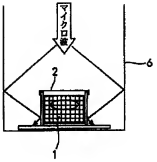
[Drawing 10]



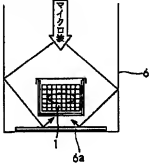
[Drawing 3]



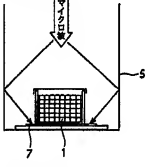
[Drawing 5]



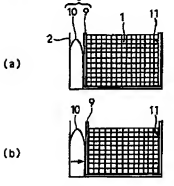
[Drawing 6]



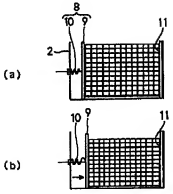
[Drawing 7]



[Drawing 8]



[Drawing 9]



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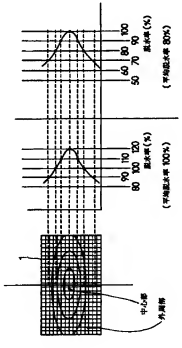
(71)出願人　000005049
シャープ株式会社
大阪府大阪市阿倍野区長池町22番22号

(72)発明者　小浜　晴之
大阪府大阪市阿倍野区長池町22番22号　シャープ株式会社内

(74)代理人　弁理士　佐野　静夫

(54)【発明の名称】　セラミック成形品の乾燥方法

(57)【要約】
【課題】　高品質のセラミック成形品が得られるようにしたセラミック成形品の乾燥方法を提供する。
【解決手段】　セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品１をマイクロ波乾燥機で７５～８５%の脱水率まで乾燥させる第１乾燥工程と、このセラミック成形品１を熱風乾燥機５で絶乾状態まで乾燥させる第２乾燥工程とから成ることを特徴とする。



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【特許請求の範囲】

【請求項１】　セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品をマイクロ波乾燥機で７５～８５％の脱水率まで乾燥させる第１乾燥工程と、このセラミック成形品を熱風乾燥機で絶乾状態まで乾燥させる第２乾燥工程とから成ることを特徴とするセラミック成形品の乾燥方法。

【請求項２】　セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品をマイクロ波乾燥機のオーブンの底面から浮かせた状態でマイクロ波を照射することを特徴とするセラミック成形品の乾燥方法。

【請求項３】　セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品をマイクロ波吸収プレート上に載置してマイクロ波を照射することを特徴とするセラミック成形品の乾燥方法。

【請求項４】　セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品の側面を押圧するための押圧部材と、この押圧部材を押圧方向に弾性付勢するとともに前記押圧部材が前記セラミック成形品の側面を押圧した状態を前記セラミック成形品の乾燥時の収縮に追従して維持する弾発部材とを備えた収縮補正用治具を準備し、この収縮補正用治具によって前記セラミック成形品を固定面に押し付けた状態でマイクロ波を照射することを特徴とするセラミック成形品の乾燥方法。

【請求項５】　セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品を水平面に対して４５°傾けた状態でマイクロ波を照射することを特徴とするセラミック成形品の乾燥方法。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明はセラミック成形品の乾燥方法に関するものであり、特に、電化製品や自動車の排ガス処理等に使用されるハニカム状のセラミック成形品の乾燥方法に関するものである。

【０００２】

【従来の技術】周知のように、電化製品や自動車の排ガス処理等にハニカム状のセラミック成形品（以下、セラミック成形品という）が広く使用されている。このセラミック成形品は、通常、次のような工程によって製造される。即ち、セラミック原料にバインダー及び水を加えて混練した坏土を押出成形機によってハニカム状に押し出し成形し、得られた高含水率のセラミック成形品を所定の寸法に切断した後、乾燥工程でほぼ絶乾状態にまで乾燥させ、さらに焼成工程で熱処理する。

【０００３】焼成工程前の乾燥したセラミック成形品において重要な事は、①収縮率が均一であること、②成形品内部に乾燥密度の差が無いこと、③成形品の表面や内部にクラックが無いこと、④寸法精度が均一であること、であり、これらの条件をクリアーしないと商品質のセラミック成形品が得られない。

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【０００４】一般にセラミック成形品の乾燥方法としては、自然乾燥、強制乾燥、遠赤輻射乾燥等のいわゆる外熱乾燥方式と、マイクロ波のエネルギーを利用した内熱乾燥方式とがある。前者は熱風やヒータの熱エネルギーをセラミック成形品の外部より伝達する方式であるが、セラミック成形品の内部の乾燥が不十分なうちにセラミック成形品の外部が収縮するので、内外の乾燥収縮の差が大きく、乾燥が不均一になり易い。

【０００５】このため、従来より、セラミック成形品を乾燥させる場合には、後者のマイクロ波エネルギーを利用した方式が採用されている。この方式は、オーブン内でセラミック成形品にマイクロ波を照射するものであるが、マイクロ波のエネルギーが成形直後のセラミック成形品に含まれる水分に内部から吸収されるので効果的である。

【０００６】なお、マイクロ波乾燥機では、均一な乾燥ができるように、設備的には、①オーブン内での場所によるマイクロ波の強弱や疎密の差（電波ムラ）を緩和するために撹拌用羽根を設ける、②オーブン内でセラミック成形品を移動（回転）させることにより電波ムラの影響を少なくする、③マイクロ波の発信機種を機械的に駆動してマイクロ波の発信方向を変化させることにより電波ムラを防止する、④オーブン内を減圧しながらマイクロ波を照射することにより低温での乾燥やセラミック成形品から排出される蒸気の除去を促進する、等の手段が採られており、セラミック成形品の外形や材質に応じて上記①～④の手段が適宜組み合わされている。また、直方体状のセラミック成形品を乾燥させる際には、セラミック成形品のコーナや縁へのマイクロ波の集中を緩和するために、セラミック成形品を金属製のカバーで覆うという工夫がなされている。

【０００７】

【発明が解決しようとする課題】しかしながら、上述した従来の技術では、使用するバインダー、セラミック成形品の外形寸法、ハニカムのセルの数によっては以下のような問題が生じており、品質及び歩留まり向上のために改善が望まれている。

【０００８】（乾燥の不均一に関する問題）オーブン内でセラミック成形品にマイクロ波を照射してセラミック成形品を乾燥させる場合、その乾燥状態の進捗度を確認するには、セラミック成形品のマイクロ波照射前後の重量変化を測定することによって判断している。即ち、加水した水の重量分だけ成形品の重量が減少すると絶乾状態であると判断される。しかし、実際には、平均脱水率が１００％のセラミック成形品の内部は、図３に示すよ

うに、中心部が脱水率１００%以上の過乾燥状態になっており、中心部から外周部に向かうに従って脱水率が低くなっている。特に、セラミック成形品の内部に過乾燥の部分が形成されると、バインダーや保形剤の効果が著しく劣化するので、これを避けなければならない。

【０００９】また、マイクロ波をセラミック成形品に照射する場合、図５に示すように、マイクロ波のエネルギーが集中する部分（楕円形の部分）がセラミック成形品１の中心部よりずれることがあり、この場合、乾燥が不均一になるとともに非効率的になる。

【００１０】（寸法精度に関する問題）上述したように、通常、セラミック成形品は押出成形によって製造されており、坏土を成形機のスクリューの回転押し出し圧力で金型を通して押し出すことによって成形されるが、坏土のねじれを緩和するために、成形機内に均圧管や整流板が設けられている。しかしながら、セラミック成形品は潜在的に坏土の方向性を有しており、その方向性は必ずしも直線的ではなく、大きな反りを持つことがある。従って、ある程度均一な乾燥ができたとしても、乾燥時の収縮に伴う外形の歪みが発生する。

【００１１】なお、セラミック成形品を均一に乾燥させるための方法としては、特公平５－２４８７５号公報のものが公知であるが、この方法では、熱風乾燥を行ってからマイクロ波乾燥を行うようにしているため、本願発明が対象とするようなハニカム状のセラミック成形品に適用すると、内部と外部の収縮率の違いによって表面にクラックが生じる。

【００１２】本発明は、上述した問題点を解決し、高品質のセラミック成形品が得られるようにしたセラミック成形品の乾燥方法を提供することにある。

【００１３】

【課題を解決するための手段】上記目的を達成するために、請求項１のセラミック成形品の乾燥方法は、セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品をマイクロ波乾燥機で７５～８５%の脱水率まで乾燥させる第１乾燥工程と、このセラミック成形品を熱風乾燥機で絶乾状態まで乾燥させる第２乾燥工程とからなることを特徴とするものである。

【００１４】なお、第１乾燥工程におけるセラミック成形品の脱水率は、ハニカムのセルの大きさが３００～４００（メッシュ／１平方インチ）の場合には８０～８５%が好ましく、ハニカムのセルの大きさが１００～２００（メッシュ／１平方インチ）の場合には７５～８０%が好ましい。また、熱風乾燥機の熱風の温度は１００℃以下であることが好ましい。

【００１５】この乾燥方法によると、セラミック成形品を第１乾燥工程で７５～８５%の脱水率まで乾燥させ、次いで第２乾燥工程で絶乾状態まで乾燥させるので、セラミック成形品が内部と外部から乾燥し、セラミック成形品全体を均一に乾燥させることができるとともに、セラミック成形品の中心部が過乾燥になるのを防止することができる。

【００１６】請求項２の乾燥方法は、セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品をマイクロ波乾燥機のオーブンの底面から浮かせた状態でマイクロ波を照射することを特徴とするものである。

【００１７】この乾燥方法によると、マイクロ波のエネルギーがセラミック成形品の底部からも吸収される。また、マイクロ波のエネルギーが集中する場所とセラミック成形品の中心部とを合わせることができる。従って、乾燥効率が向上するとともに、均一な乾燥が可能となる。

【００１８】請求項３の乾燥方法は、セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品をマイクロ波吸収プレート上に載置してマイクロ波を照射することを特徴とするものである。

【００１９】この乾燥方法によると、マイクロ波のエネルギーがセラミック成形品の底部からも吸収されるので、乾燥効率が向上するとともに、均一な乾燥が可能となる。

【００２０】請求項４の乾燥方法は、セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品の側面を押圧するための押圧部材と、この押圧部材を押圧方向に弾性付勢するとともに前記押圧部材が前記セラミック成形品の側面を押圧した状態を前記セラミック成形品の乾燥時の収縮に追従して維持する弾発部材とを備えた収縮補正用治具を準備し、この収縮補正用治具によって前記セラミック成形品を固定面に押し付けた状態でマイクロ波を照射することを特徴とするものである。

【００２１】弾発部材の種類、材質は特に限定されないが、例えば、金属製の板バネやコイルバネを使用することができる。

【００２２】この乾燥方法によると、セラミック成形品の乾燥時の収縮に追従して押圧部材がセラミック成形品の側面を押圧し続けるため、セラミック成形品の乾燥時の収縮に伴う反りが抑制される。

【００２３】請求項５の乾燥方法は、セラミック成形品にマイクロ波を照射して乾燥させるセラミック成形品の乾燥方法であって、セラミック成形品を水平面に対して４５°傾けた状態でマイクロ波を照射することを特徴とするものである。

【００２４】この乾燥方法によると、セラミック成形品の自重によってセラミック成形品の乾燥時の乾燥時の収縮に伴う反りが抑制される。

【００２５】

【発明の実施の形態】以下、本発明の具体的な実施の形

態を図面を参照しながら説明する。本実施形態で使用される乾燥前のセラミック成形品は、次頁の表１の配合の混合物を混練機で混練して得られた坏土を３本ロールで圧練し、押出成形機でハニカム状に押し出し成形した後、切断したもので、直方体状の形状を有し、外形寸法は横９０ｍｍ、高さ４０ｍｍ、長さ２００ｍｍで、重量は７００ｇ、ハニカムのセル数は２００、含水量は１０＊０ｃｃである。なお、表１の配合比率において、メチルセルロースを７重量部、紙パルプを２重量部、水を２５重量部としたときに特に好ましい結果が得られることが判明している。

【００２６】

【表１】

		重量部
セラミック原料	炭化珪素（ＳｉＣ）	７０
	金属シリコン（Ｍｅ－Ｓｉ）	３０
バインダー	メチルセルロース（ＭＣ）	５～１０
	保形剤（紙パルプ）	１～３
水		２０～３０

【００２７】図１にこのセラミック成形品の乾燥時に使用される乾燥用治具２を示す。この乾燥用治具２は、セラミック成形品１の表面の乾燥を防止するための保水カバー３と、セラミック成形品１のコーナや縁へのマイクロ波の集中を防止するための上下一対の金属製のカバー４、４とを備えている。セラミック成形品１をこの乾燥用治具２にはめ込み、マイクロ波乾燥機のオーブン内の中央部にセットし、マイクロ波を照射してセラミック成形品１を乾燥させる。

【００２８】まず、本発明の第１実施形態について説明する。この実施形態の乾燥方法は、セラミック成形品１をマイクロ波乾燥機で７５～８５％の脱水率まで乾燥させる第１乾燥工程と、このセラミック成形品１を熱風乾燥機で絶乾状態まで乾燥させる第２乾燥工程とから成っている。

【００２９】

【実施例】セラミック成形品１を乾燥用治具２にはめ込んでマイクロ波乾燥機のオーブン内にセットし、１．１ＫＷのマイクロ波を４分照射した。図２はマイクロ波による加熱時間とセラミック成形品１全体の平均脱水率の相関関係を示すグラフである。このグラフに示すように、５分でセラミック成形品１全体の平均脱水率が１００％に達するが、この時、セラミック成形品１内部の状態は、図３に示すように、中心部が脱水率１００％以上の過乾燥の状態になっており、外周部にゆくに従って脱水率が低下している。この状態で焼成を行うと強度や品質の低下につながる。そこで、この第１乾燥工程ではマイクロ波の照射時間をセラミック成形品１全体の脱水率が８０％となる４分としている。この場合、図３に示すように、セラミック成形品１の中心部の脱水率がほぼ１００％で、外周部にゆくほど脱水率が低くなっている。

【００３０】第１乾燥工程で上記の状態まで乾燥させたセラミック成形品１を第２乾燥工程では熱風乾燥機で絶乾状態まで乾燥させる。この時の乾燥条件は、熱風の温度を１００℃以下とし、セラミック成形品１を、図４に示すように、ハニカムの端面（目開き部）に熱風が当たるように熱風乾燥機５内にセットし、乾燥時間は６０分である。これによって得られたセラミック成形品は、全体の収縮率が安定した、クラックの無い高品質のものであった。

【００３１】次に、本発明の第２実施形態について説明する。マイクロ波乾燥機でセラミック成形品を乾燥させる場合、オーブン６内でのマイクロ波の照射状態を確認すると、図５に示すように、マイクロ波はセラミック成形品１の上方から照射され、オーブン６の内壁や乾燥用治具２で反射してセラミック成形品１に吸収される。図５に示すように、マイクロ波のエネルギーが集中する場所（楕円形の部分）とセラミック成形品の中心部とがずれていると、乾燥が不均一になるとともに、乾燥効率が悪くなる。そこで、この実施形態では、図６に示すように、セラミック成形品１をオーブン６の底面６ａから浮かせ、この状態でセラミック成形品１にマイクロ波を照射する。

【００３２】この乾燥方法によると、マイクロ波のエネルギーが集中する場所とセラミック成形品の中心部とを一致させることができる。また、マイクロ波のエネルギ

一がセラミック成形品の底部からも吸収される。従って、乾燥効率が向上するとともに、均一な乾燥が可能となる。

【0033】次に、本発明の第3実施形態について説明する。この実施形態では、図7に示すように、セラミック成形品1をマイクロ波吸収プレート7上に載置してマイクロ波を照射する。

【0034】この乾燥方法によると、マイクロ波のエネルギーがセラミック成形品1の底部からも吸収されるので、乾燥効率が向上するとともに、均一な乾燥が可能となる。

【0035】次に、本発明の第4実施形態について説明する。上記実施形態では、セラミック成形品1を乾燥させた場合、その横幅が90mmから85mmに収縮する。そして、収縮する際に成形時の坏土の癖が反りとなって現れるので、その補正が必要である。そこで、この実施形態では、図8、9に示すように、セラミック成形品1の側面を押圧するための押圧部材9と、この押圧部材9を押圧方向に弾性付勢するとともにセラミック成形品1の乾燥時の収縮に追従して押圧部材9がセラミック成形品1の側面を押圧した状態を維持する弾発部材10とを備えた収縮補正用治具8を準備し、この治具8によってセラミック成形品1を固定面11に押し付けた状態でマイクロ波を照射する。

【0036】図8のものでは、弾発部材10が帯状の金属板の一方の端部をアール状に折り返した板バネであり、この弾発部材10が乾燥用治具2の側壁の内面にスポット溶接で取り付けられている。治具8によってセラミック成形品1の一方の側面が押圧され、他方の側面が固定面11に押し付けられている。セラミック成形品1が図8（a）に示す乾燥前の状態から収縮すると、図8（b）に示すように、押圧部材9が弾発部材10によって矢印方向に移動し、セラミック成形品1の収縮に追従して押圧部材9がセラミック成形品1の側面を押圧し続けるので、セラミック成形品1の反りが抑制される。

【0037】図9のものでは、弾発部材10がコイルバネであり、一端が乾燥用治具2の側壁の内面に固定されている。その他の構成は図8のものと同様である。セラミック成形品1が図9（a）に示す乾燥前の状態から収縮すると、図9（b）に示すように、押圧部材9が弾発部材10によって矢印方向に移動し、セラミック成形品1の収縮に追従して押圧部材9がセラミック成形品1の側面を押圧し続けるので、セラミック成形品1の反りが抑制される。

【0038】次に、本発明の第5実施形態について説明する。この実施形態では、図10に示すように、セラミック成形品1が支持台12上に載せられており、セラミック成形品1が水平面に対して45°に傾いた状態でマイクロ波を照射する。

【0039】この乾燥方法によると、セラミック成形品1の自重によってセラミック成形品1の乾燥時の反りが抑制される。

【0040】

【発明の効果】請求項1のセラミック成形品の乾燥方法によると、セラミック成形品を第1乾燥工程で75～85%の脱水率まで乾燥させ、次いで第2乾燥工程で絶乾状態まで乾燥させるので、セラミック成形品の内部と外部から乾燥し、セラミック成形品全体を均一に乾燥させることができるとともに、セラミック成形品の中心部が過乾燥になるのを防止することができる。従って、高品質のセラミック成形品を得ることができる。

【0041】請求項2のセラミック成形品の乾燥方法によると、セラミック成形品をマイクロ波乾燥機のオーブンの底面から浮かせた状態でマイクロ波を照射するので、マイクロ波のエネルギーがセラミック成形品の底部からも吸収される。また、マイクロ波のエネルギーが集中する場所とセラミック成形品の中心部とを合わせることができ、乾燥効率が向上するとともに、均一な乾燥が可能となる。従って、高品質のセラミック成形品を得ることができる。

【0042】請求項3のセラミック成形品の乾燥方法によると、セラミック成形品をマイクロ波吸収プレート上に載置してマイクロ波を照射するので、マイクロ波のエネルギーがセラミック成形品の底部からも吸収され、乾燥効率が向上するとともに、均一な乾燥が可能となる。従って、高品質のセラミック成形品を得ることができる。

【0043】請求項4のセラミック成形品の乾燥方法によると、セラミック成形品の側面を押圧するための押圧部材と、この押圧部材を押圧方向に弾性付勢するとともに前記押圧部材が前記セラミック成形品の側面を押圧した状態を前記セラミック成形品の乾燥時の収縮に追従して維持する弾発部材とを備えた収縮補正用治具を準備し、この収縮補正用治具によってセラミック成形品を固定面に押し付けた状態でマイクロ波を照射するので、セラミック成形品の乾燥時の収縮に追従して押圧部材がセラミック成形品の側面を押圧し続け、セラミック成形品の乾燥時の収縮に伴う反りが抑制される。従って、高品質のセラミック成形品を得ることができる。

【0044】請求項5のセラミック成形品の乾燥方法によると、セラミック成形品を水平面に対して45°傾けた状態でマイクロ波を照射するので、セラミック成形品の自重によってセラミック成形品の乾燥時の収縮に伴う反りが抑制される。従って、高品質のセラミック成形品を得ることができる。

【図面の簡単な説明】

【図1】　セラミック成形品1および乾燥用治具2の斜視図。

【図2】　マイクロ波による加熱時間とセラミック成形品1全体の平均脱水率の相関関係を示すグラフ。

【図３】　セラミック成形品１内部の乾燥状態を示す図。

【図４】　熱風乾燥機５内部にセラミック成形品１をセットした状態を示す図。

【図５】　マイクロ波乾燥機のオーブン６内部の状態を示す図。

【図６】　本発明の第２実施形態を示し、マイクロ波乾燥機のオーブン６内部の状態を示す図。

【図７】　本発明の第３実施形態を示し、マイクロ波乾燥機のオーブン６内部の状態を示す図。

【図８】　本発明の第４実施形態を示し、収縮補正用治具８を使用してセラミック成形品１を乾燥させる状態を示す図。

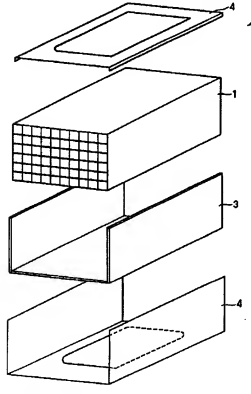
【図９】　本発明の第４実施形態を示し、収縮補正用治＊具８を使用してセラミック成形品１を乾燥させる状態を示す図。

【図１０】　本発明の第５実施形態を示し、セラミック成形品１を水平面に対して４５°傾けて乾燥させる状態を示す図。

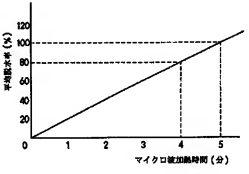
【符号の説明】

１　セラミック成形品
５　熱風乾燥機
６　マイクロ波乾燥機のオーブン
７　マイクロ波吸収プレート
８　収縮補正用治具
９　押圧部材
１０　弾発部材

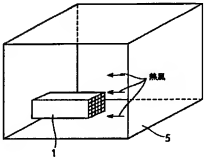
【図１】



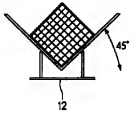
【図２】



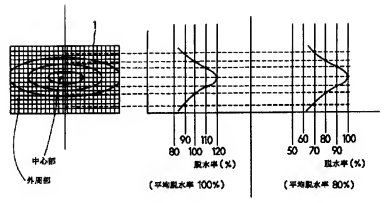
【図４】



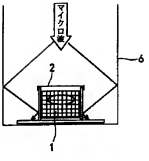
【図１０】



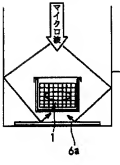
【図３】



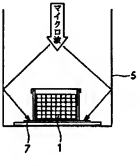
【図５】



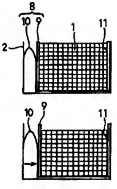
【図６】



【図７】



【図８】



【図９】